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Specification and Drawings, as originally filed, with Application for Patent Serial No: **2,,266,297**, on March 19, 1999, by **SELECT MOLECULAR TECHNOLOGIES CORPORATION**, assignee of Dmitry N. Borisenko and Nikolay N. Borisenko, for "Method of Commutation and Installation of High Capacity Accumulators".

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November 5, 1999

Date

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(CIPO 68)

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METHOD OF COMMUTATION AND INSTALLATION OF HIGH CAPACITY ACCUMULATORS

The novelty and distinctiveness of this method of commutation and installation is based on the distinctive nature of EMONA from traditional electro-chemical charging-discharging sources of energy (HIT).

Distinctive Features and Qualities

EMONA is a device consisting of at least one, more often, of several, cells separated among themselves and from the current collectors by chemically inert conducting separators invisible for particles of the electrolyte; each of these cells includes in itself a couple of electrodes consisting of one or multi-layer chemically inert carbonised activated conducting weaved fabric, which has a developed surface, active centres and orderly structure; the electrode pairs are separated among themselves by a chemically inert non-conducting transparent for the particles of electrolyte membrane. The whole device is enclosed in an airtight case.

The electrolyte that is used in this case is a liquid substance (pure liquid, liquid mixture, solution, gel and the like). The electrodes and the chemically inert non-conducting transparent for the particles of electrolyte membrane are saturated with this substance.

The electrolyte is usually in the adsorbed state in the material of electrodes and the membrane, where the free volume of the electrolyte is absent.

The electrolyte is in direct contact with the chemically inert conducting surface of both electrodes.

Each cell of EMONA is originally symmetrical in relation to the chemically inert non-conducting transparent for the particles of electrolyte membrane.

One of the substantive distinctions of the known HITs is the choice of such materials and conditions for the work of EMONA which allow absence of any chemical reaction between the electrolyte and the electrodes. The energy collection is possible primarily due to the arrangement of the electrolyte particles.

Therefore, the mass transformation on the electrodes is absent and it becomes impossible to use formulas corresponding to HITs of the kind $dm = k*dQ$ where m is the mass of the substance that reacted; k is the electrochemical index and Q is the charge that took place, etc. It is impossible to operate within the parameters of ampere-hours, etc.

As a result of the above-mentioned distinctive features, the characteristics of EMONA (Scheme No. 1) are substantially different from the characteristics of HITs (Scheme No. 2); also, the difference exists in the demands and limitations of the conditions for charging and discharging. Therefore, the engineering approach to the commutation and installation is different for the purpose of providing the maximum activity and longevity of service for such devices.

For example, when charging EMONA (Scheme No. 1a), certain value of the charging voltage U_{ch} provides certain limitations. Its increase provides a negative influence on the longevity of the device service. During the initial period of charging, the amount of the charging current can be unlimited and is defined only by the correlation between the user's resistance and the source under the running voltage. Once the value of the voltage U_{reg} is reached, the amount of the charging current must be forcefully decreased ~~based on the need not to increase~~ $\cancel{U_{ch}}$~~. The time for charging is not limited. Provided that~~ there is an unlimited amount of time for charging, the charging current will decrease to zero and voltage on EMONA will be equal to the charging voltage.

During the discharge of EMONA (Scheme 1b), the voltage is decreased from a certain level of voltage U_{nom} down to zero (subject to an unlimited amount of time for charging). The resulting minimum voltage is not limited. The discharging characteristic on a big space can be described exponentially but following correlation

$$U = Uo*EXP^{(-\frac{t}{R*C})}$$

(for charging, continuous resistance), where U and Uo are the running and the original voltage respectively, B; t is the time in seconds; R is the resistance of the chain, Om; C is the capacity, F. The discharging current can be of any value even that of the short circuit.

EMONA also allows connection to the source under the conditions of reversed polarity and into the chain of the alternative current.

This allows a hundred percent discharge of the devise without any influence on the characteristics and the longevity of its service.

The charging of HITs (Scheme 2a) is usually done at a certain stable value of the charging current I_{ch} during a certain said amount of time from zero to T_{end}. This provides the required electrochemical transformation of a certain amount of the working substance. The value of the charging current during the whole period of time of charging is limited. Increasing the value of the charging current or the time period for the charging results in HITs getting out of order.

During the charging the voltage on the device changes in very minute amounts.

During the discharge of the HITs, as well as during their charge, the amount of the ~~working substance which reacted that is proportional to the spent charge serves as a~~ limiting factor. The discharge is limited by a certain amount of time from zero to T_{end}, during which the voltage decreases to U_{end}. The charging characteristics over a large period of time can be described in a linear dependance. Fluctuations in the voltage are limited during further discharge and with the corresponding decrease in the voltage the device gets out of order because of the side effect chemical reactions. A very minimal change in the voltage on the device is allowed.

Discharges by currents over a certain value are also not allowed because of possible side effect reactions in the working substance. Therefore, no more than 25-50% of the saved energy can be given into the outside network without negatively influencing the longevity of the device service.

Characteristics of Charging EMONA

When charging two or more modules of EMONA from the same charging device, all modules are connected to it parallelly. This guarantees that the charging voltage does not get over the nominal value for all the modules.

If they are connected subsequently, subject to the same current, going through all the modules, even with minute differences in the volumes and resistance of certain modules, the voltage in them will be different. This can result in the voltage on one of the modules exceeding the level allowed, thus leading to the increase in the resistance caused by over voltage, and subsequent increase in the voltage on the module. All of this will result in the module getting out of order and the battery being useless for any further exploitation.

Such reaction is observed only when the modules are connected subsequently to the source. If we take a single module, which contains as a rule two or more subsequently connected cells, such reaction is not observed. This can be explained by the fact that all subsequently connected cells of the modules are contained in a single air-tight case and ~~the fact that a certain clearance exists between the cells and the walls of the device, and~~ the facing side of each cell communicates with the atmosphere of the general clearance of all the cells. Within such general clearance, dynamic leverage is established between the electrolyte, adsorbed by the electrodes, the membrane, on the fumes, the aerogel and the electrolyte condensate. When such system is discharged, the existing differences between separate cells are compensated due to the additional evaporation and adsorption of the electrolyte. Quick compensating leveraging of the parameters of the cells is possible

due to a limited amount of the electrolyte (the free amount is absent) and a large surface available for the evaporation and adsorption.

In case of the HITs, consisting of two or more elements, their getting out of order is associated with the difference in the parameters of separate elements. In such cases the realization of such compensating method of leveraging the parameters of separate elements is complicated due to the fact that there exists a large volume of the running electrolyte and a small surface on which evaporation and condensation can take place. The amount of time necessary for such compensation would be high and the system would not be able to catch up with the leveraging each time during the average statistical charge cycle. The voltage on any such element usually does not go about 3V. The process of charging a battery of such isolated elements connected parallelly will not provide consumer qualities of the device, and furthermore will demand additional control over the charging current.

Qualities of Discharging the EMONA

Although it is possible to use 100% of the saved energy of EMONA reflected in the formula

$$E = \frac{1}{2} * C * U^2$$

where E is energy, J; C is volume, F; U is voltage, V. Certain difficulties exist which are ~~caused by the decreasing characteristics of voltage and the corresponding necessity to use~~ low potential energy.

It has been practically defined that, without causing decrease in the customer qualities of most electric devices, it is possible to allow the decrease in the voltage on this source no more than by 50% which equals energy output of 60-75%, saved by EMONA, without the facility of additional regulating. This value is already substantially higher than that exhibited by other known HITs.

Since the energy output to the consumer is E=I*U*t, it is possible to increase the energy output only by increasing U on the source during the process of discharge (the current is defined only by the internal resistance of the user and is its characteristic).

The use of electronic schemes for the regulation of voltage on EMONA during the process of discharge does not lead to the increase in its efficience, since KPD of such transformation does not exceed 80-93%, that is no less than 7-20% of the energy output by EMONA is consumed by the process of transformation. At the same time the presence of such additional regulating device substantially complicate the device and makes it more expensive. The use of such schemes is reasonable only when the user is itself very sensitive to the change in the voltage.

We can illustrate the developed method of increasing the energy output in the following way:

- EMONA is a battery consisting of at least one pair of separate modules which have identical nominal voltage, primarily identical capacities, can be united in a single body or placed in separate bodies.
- At the beginning of the discharging cycle the battery modules are connected parallelly.
- When reaching a certain value of voltage and the output current which is defined on the basis of the serviceability and user qualities of the electric instrument.

For example, when decreasing the output power by 50%), the EMONA modules are switched from the parallel to the subsequent connection, which transfer increases voltage by two fold and once again allows the output to the user of the necessary power.

Such transfer can be performed once or several times depending on the available number of modules - both within the pair, and between pairs of modules.

Usually, one switch is performed. This is caused by the fact that each such switch leads to the quadruple diminishing of the battery capacity and the quadruple increase in its resistance, as well as the complication of the commutation scheme of the EMONA battery.

The above mentioned switch can be performed both manually and automatically, for example, by means of relay.

The efficiency of such method is especially obvious in situations when the characteristic of EMONA is different from the exponential dependence in such a way that the capacity at lower voltages is larger than the capacity in the initial discharge.

The EMONA battery specifically designed for the use as a power source in hand flashlight consists of two modules with nominal voltage of 3V; capacity, which is measured between 3.0 and 1.1watt at 684F, and which is measured from 1.0 to 0.368V - 947F. A bulb fed from such a battery provides a satisfying stream of light at the voltage up to 1.8V. The discharge characteristic is described on Scheme 3.

After charging the EMONA battery for 15 minutes, the longevity of good luminous emittance is 70 minutes, which period is necessary for the output of about 64% of the stored energy. When switched to the subsequent connection, 110 minutes, and the output of 91% of the saved energy.

~~Such efficiency of the energy output is impossible either with any other known type~~ of charge-discharge power source, or any other method of commutation.

<u>Scheme 1 - Quality characteristics of EMONA</u>

a) Typical charging characteristic

b) Typical discharging characteristic

Scheme 2 - Quality characteristics of HITs

a) Typical charging characteristic

b) Typical discharging characteristic

Scheme 3

The discharge characteristics of the battery consisting of two EMONA modules when using a switch between modules of parallel to subsequent connection.

The Formula of the Invention

The suggested method of commutation and installation of EMONA is based on the following:

I. When charging

I.1 When charging the EMONA battery, consisting of two or more modules, all separate modules of the battery are connected to the charging device paralley.

I.1.1 Under I.1 for the EMONA battery, modules of which have identical nominal voltage, the voltage of charging does not exceed the nominal voltage for any separate module.

I.1.2 Under I.1 for the battery, separate modules of which have varying nominal voltages, the voltage of charging the battery is established at no higher than the nominal voltage for the module that has the minimal nominal voltage.

~~I.2 For the EMONA module, consisting of one or more cells, the nominal~~ voltage of charging is prescribed based on the guaranteed non-over voltage, nominal for any separate cell, taking into consideration its realization in the module of subsequent, parallel, or combined plugging during the charge.

I.2.1 For the EMONA module, under I.2, enclosed into a single for all cells airtight body, where a clearance exists between the walls of the body and the facing side of all cells, where a single equilibrium atmosphere for all cells is created.

I.2.2 Under I.2, for the EMONA module, separate cells of which consist mostly of identical substances and materials (chemically inert electrodes; electrolyte; separators conducting chemically inert non-transparent for the electrolyte particles, membranes non-conducting chemical inert non-transparent for the electrolyte particles).

I.2.3 Under I.2, for the EMONA module, separate cells of which have identical nominal voltages.

I.2.4 Under I.2, for the EMONA module, separate cells of which have primarily identical capacities.

I.2.5 Under I.2, for the EMONA module, separate cells of which have primarily identical conductance.

II. At discharge

II.1 When discharging the EMONA battery, consisting of at least two modules, which have separate bodies or are connected in pairs or more in any separate body, their commutation is conducted in a way that for at least two modules, or at least two groups of modules a switch is possible between their parallel and subsequent connection to the user.

II.1.1 The switch in II.1 is performed on the basis of energy output parameters, set by the energy user.

II.1.2 The switch in II.1 is performed manually.

II.1.3 The switch in II.1 is performed automatically.

II.1.4 Commutation in II.1 allows multiple hierarchical switches between ~~different modules in their groups, or within the groups.~~

II.2 When discharging the EMONA module, consisting of two or more groups of cells, connected in pairs within a single body, there commutation is performed in such a way that, at least for two groups of the cells, a switch can be performed between their parallel and subsequent connection to the user.

II.2.1 The switch in II.2 is performed on the basis of the energy output parameters set by the energy user.

II.2.2 The switch in II.2 is performed manually.

II.2.3 The switch in II.2 is performed automatically.

II.2.4 The commutation in II.2 allows multiple hierarchical switches performed between different groups of cells.

III. The above described method in I and II can be used for electric energy storage, which have similar charge/discharge characteristics.

Рис. 1
Фрагмент заряженного электролитического КДС.

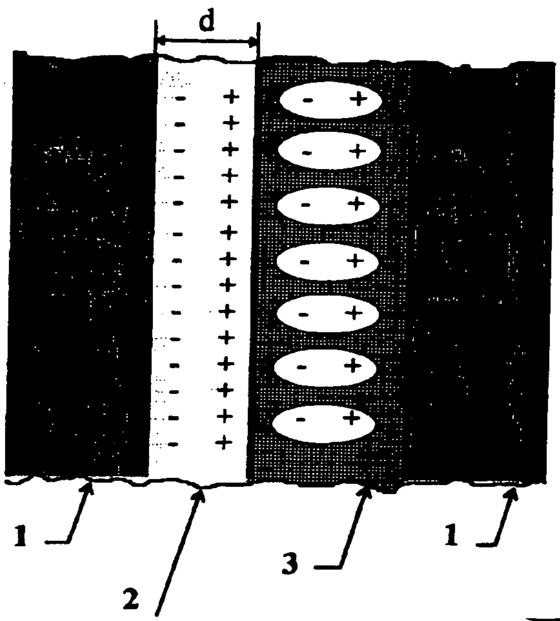
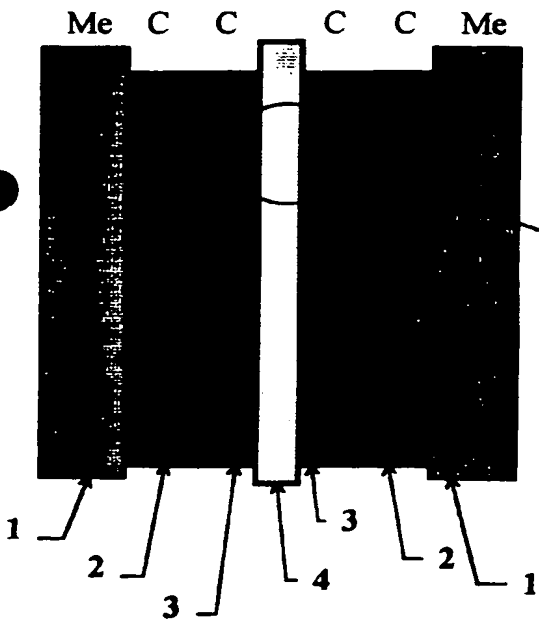


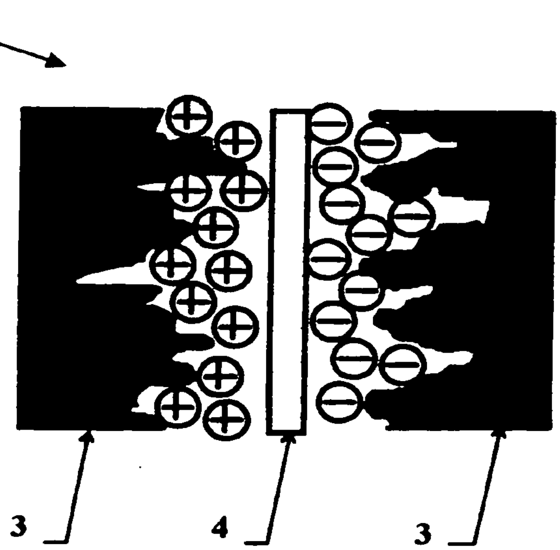
FIG. 1

1 Металлические электроды
2 Диэлектрик (оксидный слой)
3 Пористая мембрана, насыщенная “сухим” электролитом

Рис. 2
Фрагмент заряженного ЕМОНА,
элементарная ячейка, упрощенная модель



7IG. 2



7IG. 3

Токосъемники (металлические)
Инертные проводящие непрозрачные для электролита сепараторы
Электроды из карбонизированного активированного проводящего экнистого материала, имеющего упорядоченную структуру
Непроводящая прозрачная для электролита мембрана

Рис. 3
Вольт-амперная характеристика ЕМОНА

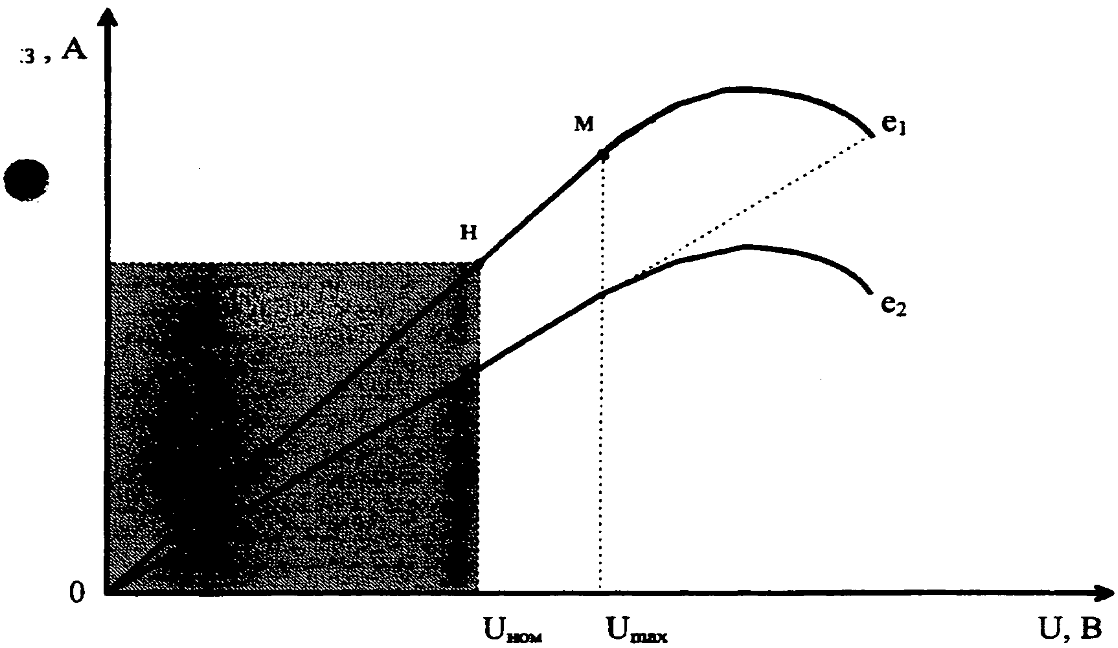


FIG. 4